HYDRAULIC FRACTURING OF NATURAL GAS WELLS IN MICHIGAN

Description

Natural gas production from hydrocarbon rich shale rock formations, known as “shale gas,” is one of the most rapidly expanding trends in onshore domestic gas exploration and production. Shale gas reservoirs are not conventional ones as normally seen in oil and gas development. The gas is more tightly locked into these shale gas reservoirs and its development relies on hydraulic fracturing (“hydrofracking,” or “fracking”). Hydraulic fracturing is a one-time procedure that is part of the completion of some types of oil or natural gas wells. More recently, horizontal drilling is being utilized, particularly in the deeper gas reservoirs. The purpose of both of these technologies is the same: to increase exposure of more reservoir rock formation to the well bore to maximize gas production.

Horizontal drilling has been used commercially since the 1980s but has not been widely applied for natural gas development until recent years. Hydraulic fracturing has been utilized throughout the United States for more than 60 years. In Michigan, since the mid-1980s, approximately 12,000 wells have been hydraulically fractured. Most of these are Antrim Shale Formation gas wells in the northern Lower Peninsula.

Hydraulic fracturing involves pumping water at high pressure to create fractures in reservoir rock that allow the oil or natural gas to flow more freely to the well bore. Proppants, usually silica sand, are added to the water to hold the fractures open once they are created. Small concentrations of chemicals are added to improve the effectiveness of the fracture job. Typically, a compound is added to increase the viscosity of the water to enable it to carry the proppant more effectively. Another typical compound is a friction-reducing additive, to allow fracturing fluids and proppant to be pumped to the target zone at a higher rate and reduced pressure than if water alone were used. Other additives include: biocides to prevent microorganism growth and to reduce biofouling of the fractures; stabilizers to prevent corrosion of metal pipes; and acids to remove drilling mud damage near the wellbore. Some of the chemical additives can have adverse health or environmental impacts if they are not properly handled and contained.

After a hydraulic fracture treatment, when the pumping pressure has been relieved from the well, the water-based fracturing fluid begins to flow back through the well casing to the wellhead. This “flowback” water may be mixed with native water from the formation itself that may contain salts and other dissolved constituents.

Regulation of Hydraulic Fracturing

Michigan has comprehensive laws and rules, enforced by the Michigan Department of Natural Resources and Environment (DNRE), that regulate hydraulic fracturing as well as every other aspect of oil and gas drilling and production. The DNRE has no evidence that hydraulic fracturing has caused any adverse impacts to the environment or public health in Michigan.

Despite the benign history of hydraulic fracturing in Michigan, it recently has become a concern to many people primarily due to issues raised in other states. The concerns center on five issues: (1) migration of gas or fracture fluids, (2) water use, (3) management of produced water, (4) surface spills, and (5) identification of chemical additives. Each issue is addressed in turn below.

Migration of gas or fracture fluids. A major concern in natural gas development is the prevention of migration of gas or other fluids out of the reservoir and into overlying strata, particularly fresh water aquifers. In cases where this has occurred, it has been the result of well construction problems and not of hydraulic fracturing itself. At depths of about 2000 feet or less, fractures propagate horizontally due to the natural stress regime of the rock. This confines the fractures to the gas reservoir. At greater depths, fractures may propagate vertically; however, characteristics of overlying rock layers prevent fractures from extending above the top of the gas reservoir.

The installation of steel pipe ("casing"), encased in cement, is key to preventing migration of gas or fluids. Michigan regulations require that each oil and gas well have a casing and cementing plan that will effectively contain gas and other fluids within the wellbore, whether related to fracturing or not. Surface casing must be set a minimum of 100 feet into the bedrock and 100 feet below any fresh water zones and cemented from the base of the casing to the ground surface. Before fracturing or other operations can take place to complete a well for production, an additional string of production casing must be set to the depth of the reservoir and cemented in place. Depending on depth, additional protective casing may be required. To provide additional protection for aquifers and well integrity, the DNRE imposes a permit condition for wells in shallow reservoirs prohibiting hydraulic fracturing within 50 feet of the base of the surface casing.

Water use. A fracture treatment of a typical Antrim gas well requires about 50,000 gallons of water. In the emerging Utica/Collingwood Shale gas development, the amount of water needed to fracture a horizontal well is expected to be about 5,000,000 gallons. To put this in perspective, 5,000,000 gallons is the volume of water typically used by eight to ten acres of corn during a growing season. Withdrawal of water for oil and gas operations is exempt from the requirements of Michigan's water withdrawal statute; however, the DNRE is developing equivalent procedures for evaluation of the potential effects of water use for large fracture jobs. The DNRE will not approve a withdrawal of water for hydraulic fracturing if it is likely to cause an adverse impact to groundwater or surface water.

Management of produced water. Proper management of flowback water is essential in protecting public health and the environment. In Michigan, all flowback water (as well as water produced along with oil or gas during subsequent production operations) is considered as an oil and gas waste and must be managed and disposed of according to strict rules specifically applying to those fluids. The fluids must be contained in steel tanks and transported to disposal wells where they are injected into deep rock layers that are isolated from fresh water supplies. The disposal wells are licensed by both the DNRE and the U.S. Environmental Protection Agency, and must be tested periodically to assure well integrity.

Surface spills. Spills of chemical additives or flowback water can have adverse environmental or public health impacts. Michigan requires secondary containment under tanks, wellheads, and other areas where spills may be most likely. If a spill does occur, it must be reported immediately to the DNRE, and all spills must be promptly recovered and cleaned up according to strict requirements.

Identification of chemical additives. While the details on chemical compounds and concentrations of hydraulic fracturing additives are proprietary, information on the chemical class and potential health and environmental effects of additives is available in the required Material Safety Data Sheets, which must be posted wherever the additives are stored,

transported, or used. In the event of a significant spill or health hazard, the DNRE has the legal authority to obtain the necessary details on chemical composition and concentrations.

Conclusions

Michigan's laws and rules effectively protect water and other natural resources as well as public health and safety from potential adverse effects of hydraulic fracturing. The DNRE has more than 50 staff employed in enforcing these state requirements. To date, only one productive Utica/Collingwood Shale gas well has been drilled in Michigan and the potential for more extensive development is unknown; however, the DNRE is taking a proactive approach in addressing large-scale hydraulic fracturing as well as other issues associated with deep shale gas development.

While fracturing of deep shale gas wells may require larger volumes of water on a per well basis, the development is expected to require significantly fewer wells. The DNRE is proposing a well density of up to 640 acres per well, and has scheduled a hearing to address well spacing. By comparison, much of the past oil and gas development has been based on 40 to 80 acres per well.

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